R E P O R T R E S U M E S

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CONCEPT FORMATION AS A FUNCTION OF METHOD OF PRESENTATION AND RATIO OF POSITIVE TO NEGATIVE INSTANCES.

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REPORT NUMBER WR/D-TR-27 PUB DATE JAN 67
REPORT NUMBER CRP-2850-TR-27
REPORT NUMBER BR-5-0216-TR-27
CONTRACT OEC-5-10-154
EDRS PRICE MF-$0.25 HC-$1.28 30P.

DESCRIPTORS- *CONCEPT FORMATION, *CONCEPT TEACHING, *DISCRIMINATION LEARNING, LEARNING PROCESSES, MATHEMATICAL CONCEPTS, TRANSFER OF TRAINING, RETENTION STUDIES, ANALYSIS OF VARIANCE, VISUAL DISCRIMINATION, IDENTIFICATION TESTS, *EXPERIMENTAL PROGRAMS, *TEACHING TECHNIQUES,

TO STUDY WHICH OF SEVERAL CONDITIONS PROMOTES EFFICIENT CONCEPT LEARNING, AN EXPERIMENT INVOLVING 2 CONDITIONS, METHOD OF PRESENTATION OF STIMULI AND RATIO OF POSITIVE TO NEGATIVE STIMULI, WAS ADMINISTERED TO 80 SECOND-GRADE CHILDREN. THE CHILDREN WERE DIVIDED INTO 8 TREATMENT GROUPS. THESE 8 GROUPS WERE FORMED BY VARYING THE 2 METHODS OF PRESENTATION, SIMULTANEOUS AND SUCCESSIVE, WITH THE 4 RATIOS OF POSITIVE TO NEGATIVE INSTANCES, P100 (POSITIVE INSTANCES ON ALL TRIALS), P75, P50, AND P25. AN INSTANCE WAS THE SHOWING OF A SPECIFIC GEOMETRIC SHAPE TO THE SUBJECT. IF THE SHAPE WAS A TRAPEZOID, THAT WAS THE POSITIVE INSTANCE. ANY OTHER SHAPE WAS A NEGATIVE INSTANCE. CHILDREN RECEIVED ACQUISITION, TRANSFER, AND RETENTION TASKS. THE SCORES ON THE ACQUISITION PHASE SHOWED THAT THE SUCCESSIVE METHOD OF PRESENTATION RESULTED IN SIGNIFICANTLY MORE CORRECT RESPONSES THAN THE SIMULTANEOUS METHOD. THERE WAS NO SIGNIFICANT DIFFERENCE BETWEEN THE 2 METHODS ON EITHER THE TRANSFER OR RETENTION TASKS. THE RATIO VARIABLE DEMONSTRATED A POSITIVE RELATIONSHIP WITH PERCENTAGE OF CORRECT RESPONSES ON THE ACQUISITION TASK. ON THIS TASK, THE P25 GROUP DID SIGNIFICANTLY WORSE THAN THE OTHER 3 GROUPS. ON THE ACQUISITION TASK, THE RATIO RANKING IN TERMS OF MOST CORRECT RESPONSES WAS (1) P100, (2) P75, (3) P50, AND (4) P25. ON THE TRANSFER AND RETENTION TASKS, THE RANKINGS WERE (1) P100, (2) P50, (3) P25, AND (4) P75. THIS DOCUMENT IS BASED ON A MASTER'S THESIS DONE AT THE UNIVERSITY OF WISCONSIN. (WD)

BR-5-0216
PA 24

TECHNICAL REPORT NO. 27

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ED015779

WISCONSIN RESEARCH AND DEVELOPMENT
CENTER FOR COGNITIVE LEARNING

THE UNIVERSITY OF WISCONSIN
Madison, Wisconsin

U. S. Office of Education
Center No. C-03
Contract OE 5-10-154

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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Technical Report No. 27

CONCEPT FORMATION

AS A FUNCTION OF METHOD OF PRESENTATION

AND RATIO OF POSITIVE TO NEGATIVE INSTANCES

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Based on a master's thesis under the direction of

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June 1967

PS 000260

The research reported herein was performed pursuant to contracts with the United States Office of Education, Department of Health, Education, and Welfare, under the provisions of the Cooperative Research Program.

Center No. C-03 / Contract OE 5-10-154
CRP No. 2850

PREFACE

This Technical Report is based on the master's thesis of Nancy S. Smuckler. Members of the examining committee were Herbert J. Klausmeier, Chairman; Chester W. Harris; and Gary A. Davis.

To contribute to an understanding of, and the improvement of educational practices related to, cognitive learning by children and youth is the goal of the Center. Of primary concern are the learning of concepts and the nurturing of related cognitive skills. Conditions within the learner and conditions within the learning situation are also relevant areas of research and development.

For her investigation of concept learning in second graders, Nancy Smuckler utilized two stimulus variables from the taxonomy of variables outlined in Technical Report No. 1 of the Center. Although the successive method of presentation was more effective than the simultaneous for initial acquisition, the two methods were equally effective for retention and transfer. Statistically significant differences were not found between presentation of positive instances only and presentation of instances in two of the other three ratios of positive to negative instances; however, the mean score was higher for the presentation of positive instances only.

Herbert J. Klausmeier
Co-Director for Research

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ABSTRACT

The present experiment investigated the effect of two methods of presentation (simultaneous and successive) and four ratios of positive to negative instances (100, 75, 50, and 25 per cent positive instances) upon concept acquisition, transfer, and retention.

Subjects, 80 second graders, were randomly assigned to one of eight treatment groups and presented with 40 labeled geometric figures by means of slides. Trapezoids (labeled Trapezoid) were designated as positive instances. Other geometric shapes (labeled No) were designated as negative. At eight-figure intervals throughout training, subjects were tested on new unlabeled figures. The control group of ten Ss also received the test instances. To test for transfer and retention, subjects were requested to circle trapezoids in a booklet containing 30 novel instances.

Analyses of variance were performed on number of correct responses, the dependent variable for each phase. Results showed a significant superiority (.05) of the successive method of stimulus presentation over simultaneous presentation in the concept acquisition phase. The method factor was not found to be significant in the transfer or retention phases. Ratio of positive to negative instances appeared to be a more powerful variable in that significant findings were disclosed in both the acquisition and transfer phases. Ratios of 100, 75, and 50 per cent positive instances were significantly (.01) superior to a ratio of 25 per cent positive instances in concept acquisition. The P100 condition resulted in a consistently greater percentage of correct responses across blocks of trials. The presentation of all positive instances during acquisition resulted in a significantly (.05) greater percentage of correct responses on the transfer task than did the use of mixed ratios of 25 or 75 per cent positive instances. The P50 group gave a greater percentage of correct responses than the P75 group. The P25 group made almost twice as many correct responses on the transfer task in comparison to the acquisition task. The ratio factor was not found to be significant in the retention phase. An interaction between method and ratio did not occur in any of the three tasks. Results indicate that there was a differential effect of the stimulus variables under the three tasks.

I
INTRODUCTION

The major objective of the Wisconsin R & D Center for Cognitive Learning is to improve efficiency of learning in the schools, particularly the learning of concepts. In this connection, a taxonomy of variables associated with concept learning has been produced by Klausmeier, Davis, Ramsay, Fredrick, and Davies (1965). Their survey of experimentation already completed, 1950 - 1964, shows a large number of variables and conditions associated with concept identification. For example, a number of investigators (Huttenlocher, 1964; Yudin & Kates, 1963; Olson, 1963) have employed school-age subjects (Ss) in concept identification tasks in an attempt to delineate those conditions which result in optimal learning. Although the principles derived from concept identification experiments have frequently been extended to the classroom, failure to differentiate between concept identification and concept formation may lead to inappropriate applications of research findings.

The importance of concept formation in the educational field can be seen when the distinction between concept formation and concept identification is made. In concept formation the S acquires a novel response which was not previously in his behavioral repertoire. In concept identification, however, the S already has the necessary responses within his behavioral repertoire and he is simply asked to classify a laboratory environment in some predetermined way. Thus, concept identification assumes prior existence of a concept, and requires identification of the predetermined classification scheme (Atkins, Bower, & Crothers, 1965; Hunt, 1962). It would, therefore, appear that the majority of a child's learning activities would be appropriately characterized as concept formation.

In concept identification studies, two of many variables related to performance are successive and simultaneous presentation of instances, and ratio of positive to negative instances. For example, Bruner, Goodnow, and Austin (1956) discuss the importance of method of stimulus presentation and point out that the effect of successive encounters with instances, as compared to simultaneous encounters, is a problem which is not simply technical in nature but which critically affects the manner in which conceptual behavior unfolds. They also note that method of instance presentation has some implications for teaching practices.

Experimental comparison of simultaneous and successive presentation of stimuli has resulted in two types of findings: either a significant difference between the two methods favoring the simultaneous method or a failure to detect any differences between the two methods. Bourne (1963) examined the effects of simultaneous and successive presentation in conjunction with stimulus variability. Subjects were presented with 64 geometric designs that differed in amount of stimulus variation, quantified in terms of the degree to which the attributes of each stimulus differed from its immediate predecessor. The simultaneous method resulted in superior performance. An interaction was found between method of presentation and stimulus variation. The simultaneous method of presentation was also found to be superior by Cahill and Hovland (1960) who presented Ss with geometric figures contained in a booklet. The superiority of the simultaneous method was attributed to the easing of memory requirements, since all previous instances remained in view. In a series of three experiments Hovland and Weiss (1953) manipulated method of presentation and ratio of positive to negative instances. Stimuli consisted of geometric forms. Comparison across experiments disclosed the superiority of the simultaneous condition. Using a word sorting task Crouse and Duncan (1963) found the simultaneous method to result in significantly more correct responses, but to require a longer stimulus exposure time. Kates and Yudin (1964) also reported the superiority of the simultaneous method.

No significant difference between the two methods was reported by Reed (1950) who investigated presentation method in relation to length of a series of stimulus words. However, an interaction between method and series length was reported. For the shorter series the simultaneous method resulted in a greater number of correct responses but required more prompts per concept. Nadelman (1957) investigated the effects of presentation method and stimulus media, models versus drawings. The main effect of method was not significant.

Although experimental findings dealing with method of presentation generally support the superiority of the simultaneous method, the diversity of methodology and stimuli employed should be noted. Also to be considered is the fact that all experimental Ss were college students presented with a concept identification task. Consequently, further research is needed in order to determine the presentation method which will facilitate concept formation in children.

Research dealing with the ratio of positive to negative instances has resulted in widely divergent findings. An early study by Smoke (1933) was primarily concerned with the role of negative instances in concept identification. He defined a positive instance as a stimulus which fulfills all the requirements of the concept and a negative instance as a stimulus which does not fulfill all the requirements of the concept. Smoke simultaneously presented Ss, college students, with geometric forms. Half of the Ss received only positive instances and the remainder were presented with an equal number of positive and negative instances. The results of the study showed that Ss could learn concepts from mixed instances in about the same amount of time as Ss who were presented only positive instances. Hovland and Weiss (1953), however, found concept identification to be superior when all positive instances defined the concept. They also found that a 50 per cent ratio of positive to negative instances resulted in better performance than all negative instances. Although Hovland and Weiss also utilized geometric forms, their college student Ss were instructed as to the number of attributes and values involved in the task and the number relevant. On the other hand, Huttenlocher (1962) reported performance to be superior when mixed instances were employed. Subjects, seventh-grade boys, were presented with geometric shapes defined by either all positive instances or a 50 per cent ratio of positive to negative instances. The diversity of these findings suggests that further research is needed in order to determine the ratio condition which results in the most efficient learning for concepts of varying types and Ss of varying characteristics.

Conditions of learning, as well as stimulus variables, are associated with efficient concept learning and the ratio of positive to negative instances may be related to transfer. Fryatt and Tulving (1963) found transfer to mixed instances was best when mixed instances rather than all positive instances were utilized in original learning. College students were presented with 24 concept identification problems which were divided into two series of 12 problems. The second series of problems was considered the transfer task. Stimuli consisted of those employed by Bruner et al. (1956). Although the relationship of method of presentation and ratio of positive to negative instances to transfer is far from clear, the results of the Fryatt and Tulving study suggest that transfer should be an important consideration in the study of concept formation.

A measure other than acquisition and transfer should be taken when trying to evaluate the conditions which promote efficient learning of concepts. Reed (1950) reported that simultaneous presentation of stimuli resulted in better retention than did successive presentation of stimuli. Thus, it is important to consider retention when examining concept formation.

STATEMENT OF THE PROBLEM

The purpose of this experiment is to investigate the effects of method of stimulus presentation and ratio of positive to negative instances on acquisition, transfer, and retention of concepts. The specific questions to be answered are:

1. What are the effects of successive and simultaneous presentation of stimuli upon the acquisition, transfer, and retention of a concept?
2. What are the effects of four ratios of positive to negative instances upon the acquisition, transfer, and retention of a concept?
3. Does method of presentation interact with ratio of positive to negative instances in the acquisition, transfer, and retention of a concept?

SIGNIFICANCE OF THE STUDY

The principles of concept identification have frequently been extended to the classroom, but in reality concept formation is just as important in the classroom situation. This experiment hopes to determine whether some of the principles which have been derived by concept identification studies will also hold true for concept formation. If principles can be generalized, future application of these principles to the classroom will be possible.

The results of this experiment would also seem applicable to the educational situation in a more specific manner. It is thought that by the second grade a child is capable of attaining geometric concepts, such as trapezoid, but no empirical work has been undertaken to demonstrate whether this is the case.

In addition, the present study explores the relationship between method of presentation and ratio of positive to negative instances. While experiments studying method of presentation have yielded fairly consistent results, the case of positive and negative instances is not as clear-cut. The possible relationship between these two main effects might explain the experimental inconsistencies which have been found.

Retention and transfer are also considered here since little is known of the effects of method of presentation and ratio of positive to negative instances upon these two processes.

II
REVIEW OF RELATED LITERATURE

In this chapter emphasis will be placed on concept identification studies manipulating the independent variables of method of presentation and ratio of positive to negative instances. The relation of these variables to the processes of transfer and retention will also be considered. Although a vast body of literature is concerned with retention and transfer of concepts, there is a lack of experiments that deal directly with the effects of method of presentation and ratio of positive to negative instances while studying the transfer or retention of a concept. Consequently, the last two processes will receive only brief attention.

METHOD OF PRESENTATION

Bourne, Goldstein, and Link (1964) pointed out that method of presentation can be considered a continuum of stimulus availability. Operational definition of the points on the continuum is possible in terms of the number of previously presented instances to which the S has access on any trial. With the successive method of presentation only one instance at a time is made available to the S. In the simultaneous condition the S has access to all instances. These two methods of presentation constitute the end points of the stimulus availability continuum. Concept identification experiments manipulating the independent variable of method of presentation have reported two types of findings. One group of studies (Nadelman, 1957; Reed, 1950) reported no significant differences between simultaneous and successive presentation of stimuli. A second group of experiments (Bourne, 1963; Cahill & Hovland, 1960; Kates & Yudin, 1964) noted the superiority of the simultaneous method over the successive. Experimenters finding the simultaneous method to be superior suggest that memory was less taxed as more instances were made available. None of the reviewed studies have reported a superiority due to the successive method.

No significant differences were found by Nadelman (1957) when investigating the effects of the two presentation procedures, simultaneous and successive, and two types of stimulus media, three-dimensional models and drawings. Although the main effect of method was not significant, method did interact with type of stimulus media. Use of the simultaneous method with models resulted in earlier concept attainment; with drawings the successive method usually required fewer prompts per concept.

Reed (1950) tried to determine the influence on concept learning of method of presentation in relation to length of a series of stimulus words. In the successive condition cards were employed as stimulus materials. Each card had four unrelated English words on the front and a nonsense syllable on the back. One of the words belonged to a category for which the nonsense syllable was a symbol. The S's task was to learn the name of the card and its meaning. In the simultaneous condition, lines of words, headed by the proper nonsense syllable, were typed on one page. Learning effort was measured by the number of promptings per concept required to name all the cards correctly on one trial. A concept was defined as a word or idea that stands for a group of things. No significant difference between the two methods was found. However, an interaction between method and series length was reported. The economy of the two methods of presentation depended upon the length of the series. For each series investigated, 24, 42, or 60 cards, the simultaneous method required more prompts than the serial method. Effort was significantly larger for the simultaneous group on the shortest series, but the differences between the two methods rapidly approached zero as the length of the series was increased. The effect of form of presentation upon the accuracy of the concepts also depended upon the lengths of the series. In the 24-card series the simultaneous group named a significantly greater number of the concepts

correctly. No significant differences were found between either method of presentation on the 42- or 60-card series.

However, Crouse and Duncan (1963) reported simultaneous presentation produced a significantly greater number of correct responses. A word sorting task was employed to study method of presentation. Subjects were required to sort 20 words from four concepts to sample instances of the same concepts. The 20 words were presented on cards that were shuffled thoroughly before the experiment. For simultaneous presentation, all of the unsorted instances were spread out before the S. Consequently, the S could make comparisons among instances and control the order of sorting. In successive presentation the unsorted instances were in a deck from which the S had to draw one instance at a time. Determination of the order of sorting or comparisons among instances was therefore not possible. Although the simultaneous condition produced more correct responses, more time was required for sorting the words.

Bourne (1963) compared the performance of Ss in a concept attainment task using two types of stimulus variation and two methods of presentation. Each of 64 different geometric designs was printed on a separate card. In the simultaneous condition, all 64 cards were presented in an ordered array and the S was allowed free inspection during the entire experimental session. In the successive condition stimuli were displayed one at a time. Amount of stimulus variation was quantified in terms of the degree to which each stimulus differed from its immediate predecessor, the number of attributes of the stimulus which changed from one trial to the next. The simultaneous method was superior to the successive method. An interaction was found between presentation method and type of stimulus variation. Bourne attributed the inferiority of the successive condition to the fact that Ss were forced to rely on memory of previous instances.

In a series of three experiments, Hovland and Weiss (1953) examined the effects of presentation method and ratio of positive to negative instances. A "closed" system concept model was employed in that the character of the concept to be learned was specified to the S. He was told what attributes were involved, how many were relevant, and the number of values for each attribute. In the first experiment all positive or all negative instances were presented successively by means of a series of Weigl-type cards. The same cards were presented simultaneously in the second experiment. In the third study flower design cards were used to simultaneously present positive, negative or mixed instances. Comparison across experiments demonstrated the superiority of the simultaneous procedure in yielding more rapid learning than the successive method.

Cahill and Hovland (1960) utilized the closed system concept model which Hovland and Weiss (1953) had employed, but transmitted the concept by negative instances of geometric shapes contained in a booklet. In the simultaneous condition each page of the booklet contained a new instance plus all previously presented instances. Answer sheets, on which the S was required to record his best guess as to the concept involved, were alternated with each of the pages portraying instances. In the successive condition an instance was no longer available after the exposure period. This was effected by presenting only new instances on successive pages of the booklet. Answer sheets were again interspersed between pages of instances. The authors felt that the simultaneous presentation of stimuli simulated "unlimited memory" by allowing all instances to remain in view, while the successive, or "limited memory," condition allowed only one instance to be exposed. Concept attainment under simultaneous presentation was significantly superior. The successive method resulted in more memory errors.

In earlier studies (Hovland & Weiss, 1953; Cahill & Hovland, 1960; Bourne, 1963) only the end points of the continuum of method of stimulus presentation were considered. In order to more completely evaluate the effects of method of presentation, Bourne, Goldstein, and Link (1964) systematically varied the amount of previous information available to Ss. Problems containing one, two or three relevant attributes were employed. Subjects were allowed to view 0, 4, 6, 8, or 10 instances. Results indicated that, in general, performance was significantly facilitated by the availability of previous stimuli. Availability had less effect in simple problems, those involving only one or two relevant attributes. A major role of availability was in the reduction of memory errors. Most of the errors made by Ss in the successive group were attributed to a failure to recall previously displayed information.

As in the Crouse and Duncan (1963) study, time was found to be of importance when considering presentation method. When unlimited time was given for Ss to view instances, eight

instances were superior to four; conversely, when instances were presented for 15 seconds, four instances resulted in superior performance. Bourne, Goldstein, and Link maintained that a certain critical amount of time may be necessary for inspecting and drawing appropriate inferences from each exposed stimulus. As the number of available stimuli increases, length of presentation must also increase for maximally efficient performance.

Pishkin and Wolfgang (1965) investigated the effects of simultaneous and successive presentation of stimuli on a concept identification task. The test material was the Wisconsin Card Sorting Test, a pack of 64 stimulus cards each containing geometric patterns. The patterns were one, two, three, or four identical figures in one of four colors. Subjects were required to categorize the geometric patterns in accordance with one relevant attribute. The relevant attribute was a particular geometric form. In the successive condition cards were turned face down after they had been exposed, while in the simultaneous condition all instances remained in view. A slight superiority of the simultaneous method was found. Errors to problem solution, the dependent variable, were reduced by the availability of one instance. Additional instances beyond one had no appreciable effect due, possibly, to the relative simplicity of the problem.

Kates and Yudin (1964) examined three methods of presentation: a successive condition, where only the current instance appeared in view; a focus condition, where the focus card and another instance were shown at the same time; and a simultaneous condition, where the focus card, a new instance, and all previous instances were shown. A problem consisted of 13 instances. Each instance involved a combination of values of four attributes. The correct concept in each problem was a single attribute. Results showed a significant difference in the number of instances required for problem solution when the three presentation methods were compared. The most efficient performance was in the simultaneous condition and the least efficient performance occurred under successive presentation. The focus condition was intermediate in efficiency. The successive condition was also differentiated from the simultaneous and focus conditions by what Kates and Yudin labeled three types of strategies. Ideal strategies were determined by counting the number of responses maintained or changed consonant with new and previous instances. The successive group used significantly fewer ideal strategies than the focus or simultaneous groups. Responses were counted as compatible strategies when they were maintained or changed to fit with new instances. More compatible strategies were manifested by the successive group. Perceptual errors occurred when a current response did not agree with a currently presented instance. The successive group made more perceptual errors. In summary, results indicated that the successive condition was inferior in efficiency and strategies to the focus and simultaneous conditions. The simultaneous method of presentation was more efficient than the focus condition, but these two treatment groups did not differ in the strategies used.

Bruner et al. (1956) found that performance was poorer with successive presentation than with simultaneous presentation. They suggested that the strategies employed by Ss in the simultaneous condition eliminate or minimize the memory requirements in concept identification. In considering the experiments of Hovland and Weiss (1953), Cahill and Hovland (1960), Crouse and Dumcan (1963), Bourne (1963), Bourne, Goldsteim, and Link (1964), and Pishkin and Wolfgang (1965) within the theoretical framework presented by Bruner et al., it appears that whem stimulus exposure is ample, Ss will identify a concept more rapidly under simultaneous presentation. Since all stimuli are available, the S's memory is not as greatly taxed. This experiment will try to determine whether these results will also hold true for concept formation.

Although the studies on presentation method cited in this section differ in methodology, theoretical basis, and stimuli used, they indicate that a simultaneous presentation is superior to successive presentation. All experiments utilized college students and presented them with a concept identification task. Thus, caution must be exercised in applying the principles of concept identification to the area of concept formation, due to the different S populations and tasks involved. The present experiment, conducted on second graders, will try to determine whether the simultaneous method of presentation will facilitate performance on a concept formation task to a greater extent than the successive method.

RATIO OF POSITIVE TO NEGATIVE INSTANCES

In concept identification studies the instances presented to the S have been of two

types: positive instances which are examples of the concept and include the essential characteristics of the concept, and negative instances which lack one or more of the essential characteristics of the concept and are consequently examples of what the concept is not. The importance of positive and negative instances is not solely restricted to the area of concept identification, for in the formation of a concept only these two types of instances may be presented in the learning series. Some experimenters (Smoke, 1933; Hovland & Weiss, 1953; Huttenlocher, 1962) have considered instance type of major importance and treated positive and negative instances as an independent variable.

Smoke (1933) was the first to attribute importance to the role of negative instances in concept attainment. He contrasted the performance of Ss who worked with a series of instances, half of which were positive and half negative, to Ss working with positive instances only. It was the S's task to guess the correct concept after viewing instances, geometric designs, which were presented simultaneously. The all-positive group attained concepts more rapidly but final differences between the two groups were not statistically significant. Smoke's results led him to propose that the Ss came to an initially wrong conclusion much less rapidly and less frequently when they learned from mixed instances rather than only positive instances. Simultaneous presentation provided the opportunity for comparison and contrast. There was a tendency for negative instances to discourage snap judgments. A similar finding was reported by Smoke (1932) when employing successive presentation of stimuli.

In a theoretical discussion of positive and negative instances Hovland (1952) criticized Smoke for not determining the amount of information encountered in the two treatment conditions. Hovland regarded the concept learning experiment as a communication in which the experimenter transmits the combination of elements he has selected as constituting the concept through a series of messages, some of which are labeled "correct" (positive instances) and others "incorrect" (negative instances). For the theoretical model which the author employed, the relative number of the two types of instances required to attain a concept varied as a function of: the total number of attributes involved, the number of attributes which were relevant to the concept, the total number of values of each attribute, and the number of correct values for the relevant attributes. Consequently, Hovland concluded that it would be difficult to derive principles concerning the efficiency of positive and negative instances.

In a series of three experiments, Hovland and Weiss (1953) presented conjunctive concepts by means of various ratios of positive to negative instances. Using Hovland's (1952) communication analysis, they determined the minimum number of positive and negative instances needed to specify the concepts employed. This necessitated the Ss being instructed as to the number of attributes and values in each problem and the number that were relevant. Since the amount of information contained by all ratios of instances was equated, differences in concept attainment were attributed to difficulty in assimilating information conveyed by the instances. Problems defined by all positive instances were more easily solved than those defined by all negative instances. Problems defined by a 50 per cent ratio of positive to negative instances were intermediate in difficulty.

The findings of Bruner et al., suggest that the amount of information per instance is indeed important in the ease of problem solution. With disjunctive concepts, the informational value of positive and negative instances reverses, negative instances generally transmitting more information per instance. Consequently, negative instances resulted in more efficient problem solution.

Huttenlocher (1962) attempted to determine whether one-dimensional concepts were easier to learn when defined by positive instances, as compared to negative instances containing the same amount of information. A 50 per cent ratio of positive to negative instances was also examined in order to determine whether this mixed series lay intermediate in difficulty between the positive and negative series. Four combinations of instances were possible: all positive instances, all negative instances, positive instances followed by negative instances, and negative instances followed by positive instances. Four categories of problems were formed from the four possible arrangements of positive and negative instances. Subjects, seventh-grade boys, were presented with 24 problems, six in each of the four categories. Problems consisted of geometric concepts. In contrast to the Hovland and Weiss results, performance was found to be superior with one type of mixed series, negative instances followed by positive instances. Performance was poorest when all negative instances were used. All positive or

mixed, positive followed by negative instances, were about equal. In agreement with Bruner et al., Huttenlocher demonstrated that the use of negative instances to define concepts does not always adversely affect efficiency.

A second, and similar, study was undertaken by Huttenlocher (1964). The same instance combinations were presented by the same procedures to children in Grades 1, 3, 5, 7, 9, and 11. The results substantiated her previous findings. Scores on all types of problems increased through the seventh grade and then remained constant.

Working with adolescent males, Yudin and Kates (1963) employed a focus technique to administer six experimental problems. Stimuli consisted of bordered geometric figures. In each problem a positive instance was first presented. This first instance was defined as a focus instance and was shown concurrently with each additional instance presented. Instances, with the exception of the positive focus instance, were either all positive or all negative. Contrary to the Hovland and Weiss findings, the two instance conditions did not differ in the number of instances required to attain the concept or the strategies pursued. In the present experiment, unlike the Hovland and Weiss study, negative and positive instances were always presented with the positive focus instance. The findings of Yudin and Kates (1963) were confirmed by Kates and Yudin (1964). The same procedures were employed; however, an older group of males, college students, served as Ss.

Olson (1963) studied the effects of positive and negative instances on concept attainment, for he thought that this variable could be readily manipulated in the classroom to aid the student in learning. High school sophomores received concept identification problems involving pictorial and symbolic stimuli by means of a modified form of simultaneous presentation. Stimulus cards were given one at a time to the S but all cards remained in view. Subjects received either all positive or a 50 per cent ratio of positive to negative instances. The group receiving 100 per cent positive instances attained concepts more rapidly but differences between the two groups were not statistically significant. Olson's findings are in agreement with those of Smoke (1933).

Freibergs and Tulving (1961) also reported no difference between groups receiving all positive or all negative instances. Subjects were required to identify conjunctive concepts on the basis of four instances presented simultaneously. Half of the Ss worked with only positive instances, while the remaining Ss saw only negative instances. Both treatment groups were given 20 successive problems. Correct identification of concepts was more rapid for the positive group during the early trials, but the difference between group median was quite small at the end of the test session.

Mayzner (1962) examined the effects of the number of positive and negative instances presented on a verbal concept attainment task. Twelve experimental conditions were formed by combining either 2, 3, 4, or 5 positive instances with 2, 4, or 6 negative instances. Stimulus materials consisted of the word list prepared by Underwood and Richardson (1956). The main effect of positive instances was found to be significant, with the amount of time necessary to attain a concept decreasing as the number of positive instances increased. Although the main effect of negative instances was not significant, Mayzner felt that the differences between group means indicated that increasing the number of negative instances increased the time necessary to attain a concept.

Mayzner's findings, as well as Freibergs and Tulving's results, indicate that positive instances appear to facilitate concept attainment. Experimenters considering positive and negative instances in relation to memory during the acquisition of a concept have also come to a similar conclusion. Dominowski (1965) concluded that the mixing of positive and negative instances of the same concept lessens contiguity and results in poor performance. Underwood (1957), Newman (1956), and Kurtz and Hovland (1956) also came to a similar conclusion. The findings of Hovland and Weiss (1953) support the contiguity argument by demonstrating that a mixed order of instances was inferior to all positive instances. The same conclusion was reached by Witman and Garner (1963) who utilized three types of stimuli: positive instances alone, positive instances grouped (eight positive instances followed by eight negative instances), and positive instances mixed (interspersed positive and negative instances). The first condition, positive instances alone, was found to be superior with the mixed instances resulting in the poorest performance.

In summary, it should be noted that experimental findings dealing with positive and negative instances are diverse and conflicting. This is due in part to the use of different types of concepts such as conjunctive and disjunc-

tive, variety in the number of attributes and values of the concepts under consideration, and variety in the number of attributes and values considered relevant to a concept. However, one fairly consistent finding does become apparent. With the exception of the Bruner et al. findings dealing with disjunctive concepts, 100 per cent instances resulted in poorest performance. Another problem encountered in the study of positive and negative instances is the lack of attention given to various ratios of positive to negative instances. In considering mixed instances most studies employ half negative and half positive instances; only Mayzner (1962) presented various combinations of positive to negative instances. The present study will manipulate the ratio of positive to negative in order to determine the ratio condition that results in most efficient learning.

Also it should be noted that only four studies (Huttenlocher, 1962, 1964; Yudin and Kates, 1963; Olson, 1963) employed Ss who were not college students. These four studies, as well as the others cited, utilized concept identification tasks. Due to the Ss and tasks involved, further experimentation is necessary before extrapolation of the principles derived from the study of concept identification can be made to the area of concept formation.

Experiments manipulating the independent variable of positive and negative instances have not been consistent in the method of presentation employed. Differences in method of presentation may aid in explaining conflicting results. For example, using a focus condition, Yudin and Kates (1963) found no significant differences between all positive or negative instances, while Huttenlocher (1962), presenting two instances successively for each concept, found mixed instances (negative followed by positive) to be superior. Olson (1963) presented instances one at a time until all instances were in view. He found no significant differences between all positive or mixed instances. However, Hovland and Weiss (1953) reported the superiority of all positive instances over mixed instances when presenting stimuli both successively and simultaneously. The variety of presentation methods used makes it difficult to determine whether there is a consistent relationship between method of presentation and ratio of positive to negative instances.

Difficulties are also encountered when trying to determine whether method of presentation is influenced by positive and negative instances. Types of instances used in the study of method of presentation have infrequently been manipulated. Cahill and Hovland (1960) employed only negative instances when studying method of presentation. The simultaneous condition was superior to the successive. No differences between simultaneous and successive presentation were noted by Reed (1950) when only positive instances were presented.

The possibility that a relationship between these two variables exists was suggested by the findings of Hovland and Weiss (1953). Although all positive instances were found to be superior regardless of the method employed, concept attainment from all negative instances was better under simultaneous presentation as compared to the successive method. By manipulating both method and ratio, this experiment will be in a position to examine the possibility of a significant relationship between these two independent variables.

TRANSFER

An important topic in the psychology of learning is the transfer of learning. Deese (1958) concluded that there is no more important topic. Ellis (1965) felt that the psychologist working on the topic of transfer is faced with the problem of determining the fundamental conditions or variables which influence the transfer of learning. Although the process of transfer has been extensively investigated, the literature concerning the effects of method of presentation and ratio of positive to negative instances on the transfer of concepts is limited.

In the Freibergs and Tulving (1961) experiment, initial differences between Ss working with all positive instances and Ss working with all negative instances were noted. As the Ss progressed through the series of 20 problems the differences between the two groups declined. Freibergs and Tulving expressed a need for further research since results indicated that practice with positive and negative instances may play a role in the process of transfer.

Fryatt and Tulving (1963) considered a situation in which Ss received either mixed or positive instances. Subjects, college students, were divided into four groups: the first group received all positive instances; Ss in the second group received positive and then mixed instances; the third group received first mixed instances and then positive instances; and Ss in the fourth group received only mixed instances. The Ss were presented with 24 con-

cept identification problems which were divided into two series of 12 problems. Performance on the first 12 problems was compared to performance during the second series. A Bruner-type task was employed. All problems within a given series involved either three positive instances or one positive and two negative instances. The S's task was to identify conjunctive concepts involving two relevant attributes. Results indicated that there was a good deal of transfer from mixed to mixed instances. A comparison of the group receiving positive followed by mixed instances to the group receiving mixed followed by mixed instances showed the latter to be superior.

Initial differences between groups receiving positive instances in both series and mixed instances in both series were large and favored the former group. However, at the end of the transfer task there was no appreciable difference between these two groups. In other words, initially transfer from positive to positive instances was superior to transfer from mixed to mixed instances, but this difference disappeared with practice. The asymmetrical transfer effects are interpreted by Fryatt and Tulving as providing support for the hypothesis that information from positive instances is probably utilized more efficiently than that from negative instances.

Transfer from positive to mixed instances and from mixed to positive instances was also evaluated and compared. Practice with mixed instances resulted in better performance with positive instances when compared to no previous practice. However, practice with positive instances did not result in better performance with mixed instances when compared to no previous practice.

Masilela (1964) investigated the influence of positive and mixed instances on transfer in verbal concept learning. On the basis of the mediational model it was predicted that mixed, an equal number of positive and negative instances, would lead to greater transfer in new situations. Subjects, college students, were presented with stimulus words selected from the word list prepared by Underwood and Richardson (1956). Half of the Ss received only positive instances during the learning phase, the remainder were presented with mixed instances. In the transfer phase, the Ss were divided into four subgroups so that half of the Ss who received positive instances during the learning phase were presented with mixed instances on the transfer task. The other half of the original positive group received positive instances in the transfer phase. The same conditions prevailed for the group presented with mixed instances during the learning session. Half received mixed instances in the transfer phase while the remainder were presented with only positive instances. Although the group receiving only positive instances during the learning session acquired the concept more rapidly, the original mixed group exhibited superior performance on the transfer task. Transfer to positive or mixed instances was facilitated to a greater extent by the use of mixed instances in the learning session than by the presentation of only positive instances.

Although the relationship of method of presentation and ratio of positive to negative instances to transfer is far from clear, the results of the Fryatt and Tulving study and the Masilela experiment suggest that transfer should be an important consideration in the study of concept formation.

RETENTION

As far as retention is concerned, the state of knowledge with regard to the independent variables of method of presentation and ratio of positive to negative instances is similar to the findings presented in the transfer literature. Little evidence is given as to which method of presentation or ratio of positive to negative instances will maximize the retention of a concept.

A number of experiments have examined the retention of concepts after learning. For example, Lloyd (1960a, 1960b) found near perfect performance on the first relearning trial which was administered one week after the initial learning session. Oseas and Underwood (1952) and Underwood (1957) reported high retention of concepts after a 24-hour interval. Similarly, Richardson (1956) found no forgetting of concept names after a lapse of 24 hours.

As in the Lloyd studies, Reed (1950) reported high retention of concepts after one week. He investigated the influence on learning and retention of method of presentation in relation to the length of a series of stimulus words. From the standpoint of retention, the simultaneous method resulted in better performance than did the successive presentation of stimuli.

The effects of the variables of ratio of positive to negative instances and method of presentation upon the process of retention are far from clear. Reed's findings suggest the importance of considering retention when studying concept formation.

III
METHOD

SUBJECTS

One hundred eight second-grade pupils in a medium size Midwest city served as subjects. The Ss ranged in age from 7.3 yr. to 10.2 yr. with a mean age of 8.2 yr. Subjects were randomly assigned to one of eight treatment groups or to the control group. Although 12 Ss per group participated in the acquisition and transfer tasks, it was necessary to conduct the final analysis on 10 Ss per group due to absences during the retention phase. Subjects were randomly discarded from groups exceeding ten members in order to maintain equal cell frequencies. Thus, a total of 90 Ss were considered in the final analysis. In general, Ss were from middle-class families, had only limited experience with geometry, and had no formal experience with the concept "trapezoid."

EXPERIMENTAL MATERIALS

For the acquisition task, 40 instances of trapezoids and other geometric shapes were employed. Each positive instance was labeled "Trapezoid." Positive instances were constructed so as to be consistent with the definition of a trapezoid posed by Kelly and Ladd (1965), "A quadrilateral in which one pair of opposite sides is parallel and the other pair of opposite sides is not parallel [p. 197]." Positive instances varied across three dimensions: length of lines, degree of angles, and orientation. Combinations of the first two dimensions were made so as to create ten visibly distinct trapezoids. The ten trapezoids were orientated in six different directions to produce a total of 60 trapezoids. Of the 60 instances formed by the various combinations of the three dimensions, 20 remained to be used as test instances. These positive instances were unlabeled.

Negative instances, figures which did not meet the criteria of a trapezoid, were labeled "No." Of the 30 negative instances employed, 25 were quadrilaterals and 23 of these had two pair of parallel sides. The five remaining figures consisted of three triangles, an oval, and a circle. Negative instances also varied across the three dimensions of length of lines, degree of angles, and orientation.

Each of the instances was made from white paper and the lettering, when used, was also white. Instances were then placed on a black background within a 2.75 by 3.50 in. rectangular border and photographed. The enclosing border was a black and white dotted line. When the slides were projected on a screen the figure and lettering were black with a white background.

For the transfer and retention tests each S received a three-page booklet containing instructions and 30 figures, 10 to each page. Half of the figures were positive instances while the remainder were negative instances. All figures used in the transfer and retention task were novel instances in that they had not been presented during acquisition.

EXPERIMENTAL DESIGN

The experimental design for the acquisition task consisted of a 2 x 4 x 5 factorial design with two methods of presentation (Si and Su), four ratios of positive to negative instances (P100, P75, P50, and P25), and five blocks of four trials on which repeated measures were obtained. The design is illustrated in Table 1.

For transfer and retention the experimental design consisted of a 2 x 4 factorial design with two methods of presentation (Si and Su) and four ratios of positive to negative instances (P100, P75, P50, and P25). A total of eight cells were formed with ten Ss in each cell.

Table 1

Experimental Design--Acquisition

Method	Ratio	Blocks				
		1	2	3	4	5
Simultaneous	P100	$S_1 \cdot \cdot S_{10}$				
	P 75					
	P 50					
	P 25					
Successive	P100					
	P 75					
	P 50					
	P 25					

EXPERIMENTAL PROCEDURE

All Ss were presented, by means of a slide projector, with eight training instances (labeled figures) followed by four test instances (unlabeled figures) until a total of 40 training and 20 test instances were presented. Thus, there was a total of five blocks, with eight training and four test instances in each block. During the presentation of the test instances the Ss were asked to indicate whether the figure was, or was not, an example of the concept "trapezoid" by circling Yes or No on the appropriate line of an answer sheet. The control group was presented with the test instances and instructed to guess if they did not know what a trapezoid was.

In the P100 condition all training instances within a block consisted of positive instances of the concept "trapezoid." In each of the succeeding conditions, within a given training block, two positive instances were randomly[1] eliminated and replaced by two negative instances. Thus, in the P75 condition there were six positive and two negative instances; in the P50 condition, there were four positive and four negative instances; and in the P25 condition, there were two positive and six negative instances.

[1]Positive instances were randomly eliminated with the restriction that the first instance in a given block must be positive.

Instances were presented in the same order for both the Si and Su groups. In the Su condition each of the eight training instances was exposed for 9.5 seconds. Total time taken to present all eight instances was 80 seconds. In the Si condition one slide containing eight training instances was exposed for 70 seconds. The reduction in total time was necessary in order to adjust for the slide changes in the Su condition. The test instances were each presented for 12 seconds.

In the Si condition the first instance of a successive series appeared in the upper left-hand corner of the slide, the second to the right of the first, and the third directly underneath the first. This arrangement was concluded with the eighth training instance appearing in the lower right-hand corner of the slide. It should be noted that the simultaneous presentation as considered in this experiment only approximates a true simultaneous presentation in that all 40 instances are not exposed at one time.

At 45-minute intervals students were escorted from their classrooms to one of the two experimental rooms. In each room the same ratio of positive to negative instances was presented concurrently but a different method of presentation was employed. Subjects were seated at desks and answer sheets distributed. A tape recorder and slide projector were connected so that the experiment proceeded automatically once the response sheets had been distributed.

Subjects received the following instructions:

> Please print your first and last name on the top line of your answer sheet. Print your teacher's name underneath it.
>
> In the next few minutes you will be shown some pictures. They are pictures of shapes. A square is a shape and so is a circle. A trapezoid is also a shape. Can you pronounce the word "trapezoid?"
>
> When you are shown a picture of a trapezoid, the word Trapezoid will be printed underneath the shape. If you are shown a shape which is not a trapezoid the word No will be printed under the shape. Look at each shape very carefully because you will be asked some questions about these shapes.
>
> There are two things we want you to remember. Do not look at anyone else's paper and answer only when we tell you to.

We want to see how carefully you looked at the pictures. We will show you some more pictures. You must decide if the shape in each picture is, or is not, a trapezoid. If you think the shape in the picture is a trapezoid then circle Yes on your answer sheet. If it is not a trapezoid then circle No on your answer sheet. If you have a question as to where you should put your answer then raise your hand.

Now look at this shape and answer on line 1.
Now look at this shape and answer on line 2.
Now look at this shape and answer on line 3.
Now look at this shape and answer on line 4.

Subjects were then told that they would see some more shapes, and the cycle was repeated four more times until a total of 40 training and 20 test instances had been shown.

Upon completion of the slide presentation the transfer task was distributed. The task consisted of a three-page booklet containing 30 novel instances and instructions to circle only the trapezoids. The transfer task was administered 48 hours later to test for retention.

TREATMENT OF THE DATA

Number of correct responses was the dependent variable used to assess performance of the Ss on the acquisition test. A three-way ANOVA was employed to analyze the 400 scores obtained from the 80 Ss. To measure the Ss performance on the transfer and retention tests, number of correct responses was used as the dependent variable. For both transfer and retention a two-way ANOVA was employed to analyze the 80 scores obtained from the 80 Ss. The data obtained from the control group were not analyzed statistically, but the scores were used in a graphic presentation of the effects of the independent variables upon performance.

IV
RESULTS

ACQUISITION

A three-way ANOVA was computed for the dependent variable number of correct responses. The main effects tested for significance were: method of presentation, ratio of positive to negative instances, and blocks of trials. Interactions resulting from these main effects were also tested. The blocks variable was a repeated measure consisting of five observations, each composed of four trials. Consequently, five scores were reported for the 10 Ss in each of eight treatment groups. The summary of the ANOVA with number of correct responses as the dependent variable is shown in Table 2. Significant F ratios were obtained for the three main effects: method ($p < .05$), ratio ($p < .01$), and blocks ($p < .05$). None of the first or second order interactions yielded a significant F ratio.

The mean number of correct responses for each ratio by method group is listed across blocks in Table 3. The four ratio means derived by summing across method and blocks

Table 2

Summary of Analysis of Variance for Acquisition With Number of Correct Responses as the Dependent Variable

Source	df	MS	F
Method (M)	1	11.56	5.98*
Ratio (R)	3	35.28	18.27**
M x R	3	1.08	1
Ss/Groups	72	1.93	
Blocks (B)	4	1.977	3.907*
M x B	4	.655	1.294
R x B	12	.682	1.347
M x R x B	12	.356	1
B x Ss/Groups	288	.506	
Total	399		

* $p < .05$
** $p < .01$

Table 3

Mean Number of Correct Responses Per Block of Four Trials

Ratio	Blocks										Ratio Mean-Total
	1		2		3		4		5		
	S_i	S_u	S_i	S_u	S_i	S_u	S_i	S_u	S_i	S_u	
P100	2.70	2.90	2.10	2.60	2.50	3.00	2.80	2.90	3.10	2.40	2.70
P75	2.00	3.00	1.90	2.50	2.60	3.00	2.20	2.80	2.50	2.90	2.54
P50	2.40	2.70	1.90	2.40	2.30	2.70	2.50	2.80	2.30	2.80	2.48
P25	1.60	2.10	1.20	1.50	1.10	1.30	1.30	1.50	1.20	1.20	1.40
Mean Method Total Over Blocks	2.17	2.67	1.77	2.25	2.12	2.50	2.20	2.50	2.27	2.32	
Block Mean Total	2.42		2.01		2.31		2.35		2.29		

are also presented. Method means are reported for each block under which can be found the block means. The method means were 12.50 and 10.55 for successive and simultaneous, respectively.

The mean number of correct responses for Ss in the Su group differed significantly ($p < .05$) from the mean of the Si group. Subjects under the Su condition displayed superior performance to Ss under the Si condition. As shown in Figure 1, the superiority of the Su group was relatively consistent across blocks, with the exception of the fifth block of trials where the difference between the two treatment groups decreased.

Following a significant F ratio for the main effect of ratio ($p < .01$), the Newman-Keuls procedure (Winer, 1962) for probing the nature of the differences among means was employed. Results of this analysis show that the P100, P75, and P50 groups performed significantly ($p < .01$) better than the P25 group. The per cent of correct responses across blocks for each ratio group is illustrated in Figure 2. The graphic presentation of results illustrates the direct relationship between correct responses and ratio of positive to negative instances. The relationship between these two factors can also be seen in Table 3; as the proportion of positive instances increased the mean number of correct responses increased.

Chance level of performance was determined to be 50 per cent. In considering the ratio factor, the P50, P75, and P100 groups were consistently above chance level of responding. The P25 group's performance was invariably below this chance level. In considering the method factor, the Su group's performance was consistently above the chance level of responding. The Si group's performance was slightly above chance on Block 1. In the second block, performance declined to below the chance level. The Si group's performance rose above the chance level in the third block of trials, and their percentage of correct responses continued to increase in the remaining two blocks.

The significant main effect of blocks was also evaluated for differences among means by use of the Newman-Keuls procedure. A significant difference ($p < .05$) between Blocks 1 and 2 was revealed. Subjects made more correct responses in the first block of trials. More errors were made in the second block with the number of correct responses increasing in the third block and remaining relatively stable over the remaining two blocks of trials.

TRANSFER

Performance on the transfer task was evaluated on the basis of the number of correct

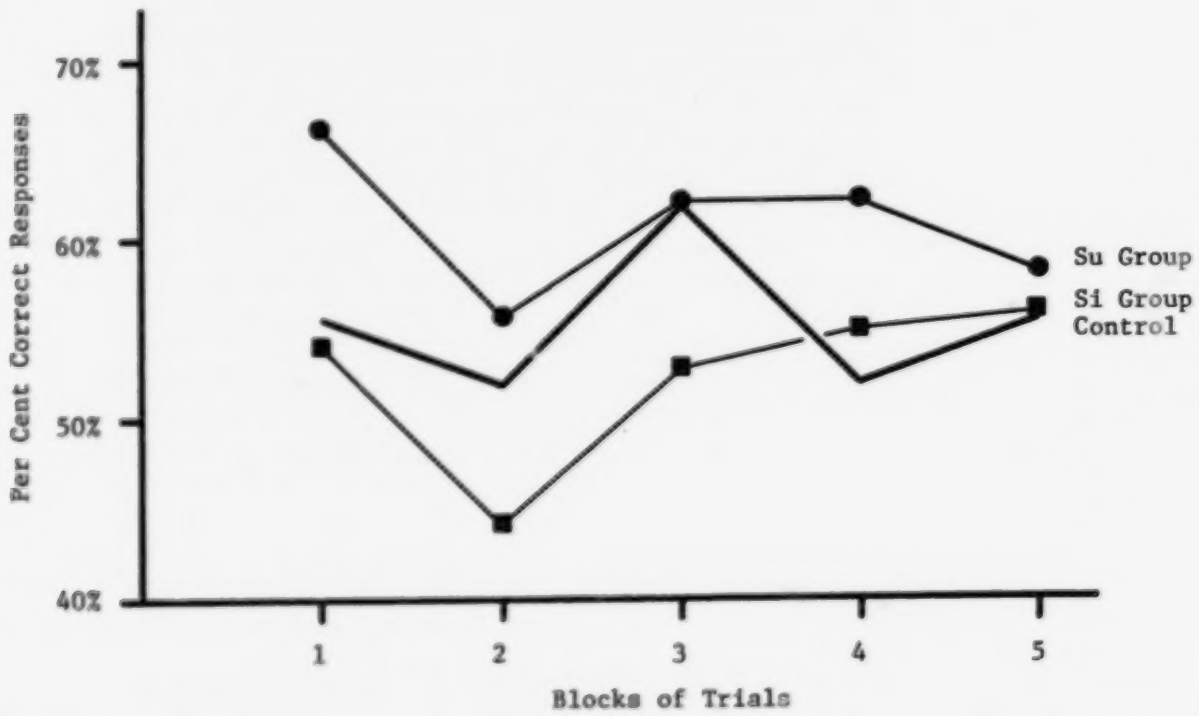

Fig. 1. Per cent correct responses over blocks of four trials as a function of method of presentation.

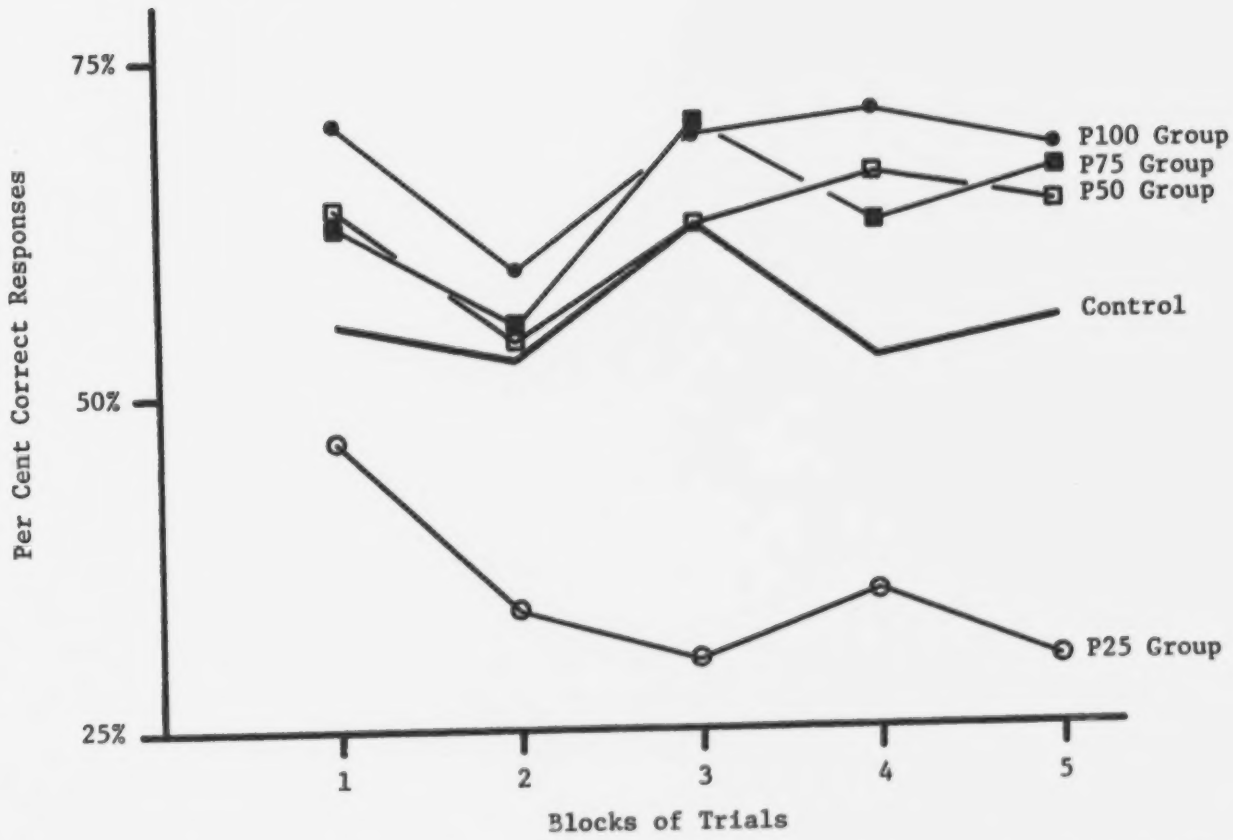

Fig. 2. Per cent correct responses over blocks of four trials as a function of ratio of positive to negative instances.

responses, the dependent variable. The two main effects tested for significance were presentation method and ratio of positive to negative instances. The resulting interaction was also tested. A two-way ANOVA was employed to analyze the scores obtained from ten Ss in each of eight treatment groups. A summary of the ANOVA with number of correct responses as the dependent variable is presented in Table 4. The main effect of ratio of positive to negative instances was found to be significant at the .05 level. The main effect of method did not yield a significant F ratio, nor did the first order interaction.

Subsequent analysis of the significant main effect of ratio of positive instances ($p < .05$) by the Newman-Keuls procedure revealed that the P100 group performed significantly better than the P25 and P75 groups. The superiority of the P100 condition is reflected in Table 5

Table 4

Summary of Analysis of Variance for Transfer With Number of Correct Responses as the Dependent Variable

Source	df	MS	F
Method (M)	1	1.0	1
Ratio (R)	3	25.6	3.82*
M x R	3	6.7	1
Ss/Groups	72	6.7	
Total	79		

* $p < .05$

Table 5

Mean Number of Correct Responses Transfer

Ratio	Method		Mean Ratio Total
	Si	Su	
P100	19.5	19.0	19.25
P75	17.6	16.6	16.8
P50	18.6	18.4	18.5
P25	16.5	17.8	17.1
Mean Method Total	18.05	17.75	

which lists the mean number of correct responses for each ratio by method combination as well as the overall means for the four ratio and two method conditions. Although the P50 group did not significantly differ from the P25 and P75 groups, the mean number of correct responses made by the P50 group was higher than these other two ratio conditions.

RETENTION

A two-way ANOVA was computed for the dependent variable of number of correct responses. Tested for significance were the two main effects, presentation method and ratio of positive to negative instances. The resulting interaction was also examined. As shown in Table 6, in which the ANOVA is summarized, neither the main effects nor the resultant interaction were significant.

Table 6

Summary of Analysis of Variance for Retention With Number of Correct Responses as the Dependent Variable

Source	df	MS	F
Method (M)	1	14.4	1.73
Ratio (R)	3	19.9	2.40
M x R	3	11.4	1.37
Error	72	8.28	--
Total	79		

Table 7 presents the mean number of correct responses for each ratio by method combination and an overall mean for each level of the main effects of method and ratio. Although differences between means were not significant, as they were in the analysis of the transfer data, a similar trend is indicated. Subjects in the P100 group made more correct responses than Ss receiving the three lower ratios of positive instances. A slight superiority of the P50 group over the P75 and P25 groups is also indicated, as was the case on the transfer task.

Table 7

Mean Number of Correct Responses Retention

Ratio	Method		Mean Ratio Total
	Si	Su	
P100	20.3	19.1	19.7
P75	16.8	18.1	17.4
P50	17.1	19.5	18.3
P25	17.3	18.2	17.7
Mean Method Total	17.8	18.6	

SUMMARY

In accord with the objective of this study, to determine the conditions which promote efficient concept learning, the independent variables were examined across tasks. Since the blocks effect was applicable to only the acquisition task, it was not considered. Similarly, the main effect of method was not discussed since it was revealed to be significant only in the acquisition phase. The main effect of ratio received further consideration since significant findings were disclosed in the acquisition and transfer data. Figure 3 depicts the per cent correct responses for each ratio condition across tasks.

As can be seen in Figure 3, the P100 group was consistently superior to all other ratio groups. Although the P100 group's performance was superior across all tasks, changes in relative ranking on the dependent variable occurred for the P25, P50, and P75 groups under the three tasks. The P75 group responded at a rate of 67.5 per cent correct responses in Block 5 of the acquisition phase as compared to 63.7 per cent correct for the P50 group. However, on the transfer task the P50 group made 61.2 per cent correct responses as compared to 56.2 per cent correct responses for the P75 group. The P50 group also made a higher percentage of correct responses on the retention test, 61.0 per cent as compared to 58.6 per cent for the P75 group. The P25 group differed significantly from the three higher ratio groups on the acquisition task in that fewer correct responses were made. The percentage of correct responses made by the P25 group increased on the transfer task. On Block 5 of the acquisition task, 30.0 per cent of the responses were correct

as compared to 57.2 per cent on the transfer task. The group receiving the P25 condition on the acquisition task made almost twice as many correct responses on the transfer and retention task. In the transfer phase the P25 group's performance differed significantly from the P100 group. On the retention test the P25 group did not significantly differ from the three higher ratio groups and changes in relative ranking on the dependent variable occurred. The P25 group made 59.2 per cent correct responses on the retention test as compared to 58.6 per cent correct for the P75 group. The results indicate that there was a differential effect of the stimulus variables under the three tasks.

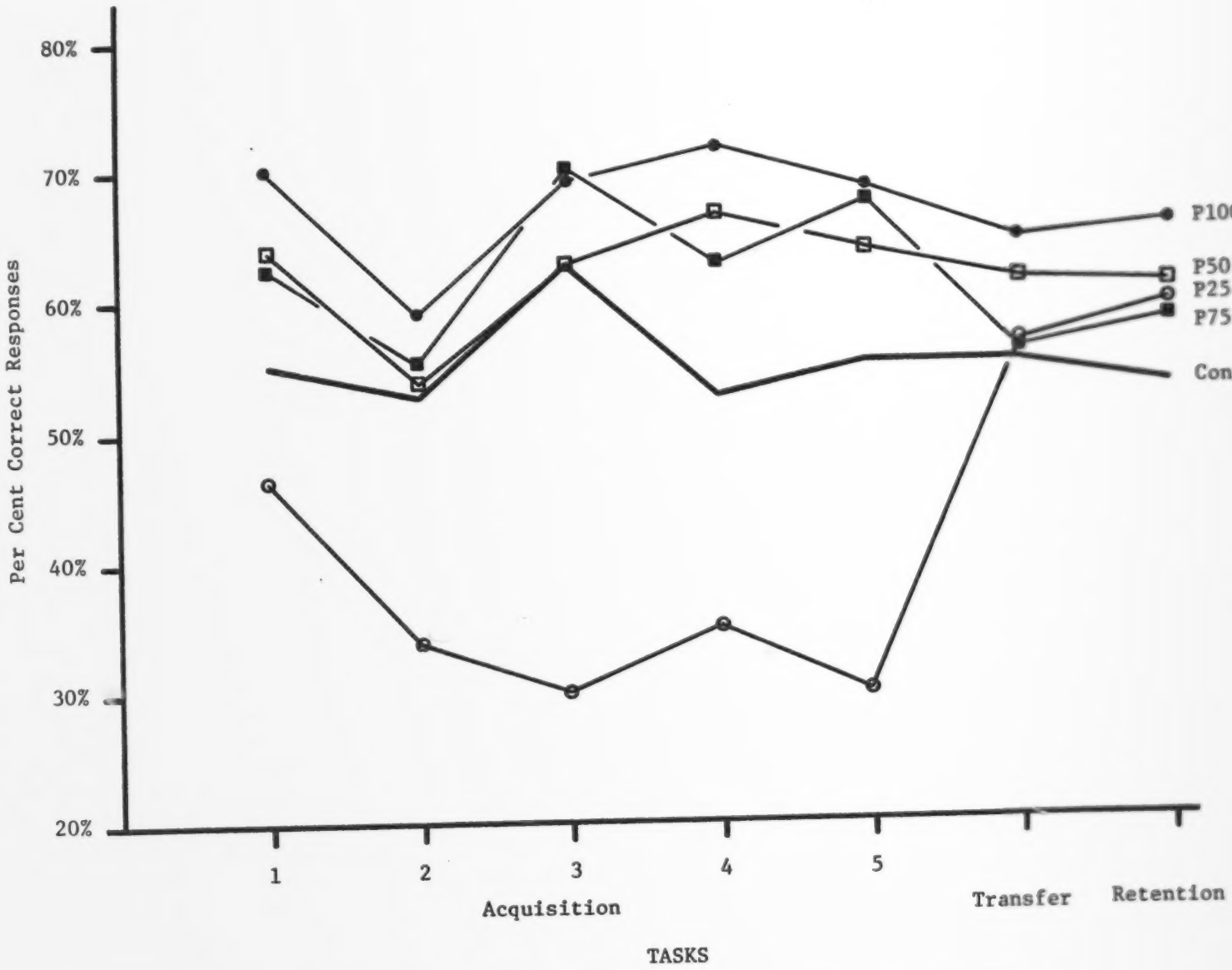

Fig. 3. Per cent correct responses for each ratio condition on each task.

V

CONCLUSIONS AND DISCUSSION

In examining the effects of method of stimulus presentation upon concept acquisition, the present study found the successive presentation method to result in a significantly (.05) greater number of correct responses. The method factor was not found to be significant in either the transfer or retention phases. While method of presentation influenced concept acquisition, the method factor was not critical in the transfer or retention of the concept.

The ratio factor was found to be a more powerful variable. Ratio of positive to negative instances was disclosed as significant in both the acquisition and transfer tasks, .01 and .05, respectively. In considering concept acquisition it appears that the ratio variable was directly related to the percentage of correct responses. As the ratio of positive instances increased the percentage of correct responses increased. The P25 group made a significantly lower percentage of correct responses than the three higher ratio groups. The group receiving only positive instances gave a consistently higher percentage of correct responses across the five blocks of trials. Results illustrate the utility of employing a ratio of 50 per cent or more positive instances for effective concept formation.

Transfer to a 50 per cent ratio of positive to negative instances was most facilitated by the use of only positive instances during acquisition. The P100 group was significantly (.05) superior to the P75 and P25 groups. Subjects receiving a 50 per cent ratio did not differ significantly from the three other treatment groups. In contrast to the acquisition phase from the P50 group made a higher percentage of correct responses on the transfer task than the P75 group. A marked improvement was noted for the P25 group; the percentage of correct responses on the transfer task was almost double the percentage made in acquisition. Although the presentation of 100 per cent positive instances during acquisition resulted in the most efficient transfer, the efficacy of a 50 per cent mixed ratio and the marked improvement of Ss presented with a mixed ratio of 25 per cent positive instances should be noted.

The ratio factor was not found to be significant in the retention phase, but the relative ranking of the four treatment groups on the dependent variable was similar to the ranking in the transfer phase. The P100 condition resulted in the highest percentage of correct responses, followed by the P50 condition; the P25 group made more correct responses than the P75 group. Retention appeared to be maximal with a 100 per cent positive ratio.

Method of presentation did not interact with ratio of positive to negative instances in any of the three tasks. The influence of the method and ratio factors appears to be differential under the three tasks.

The finding that the successive method of presentation resulted in a significantly (.05) greater number of correct responses during acquisition is inconsistent with the general trend of findings of concept identification studies. Most studies (Bourne, 1963; Cahill & Hovland, 1960; Hovland & Weiss, 1953) have reported the superiority of the simultaneous method. Inconsistent findings could be attributed to fundamental task differences, the age disparity of the S population sampled, the influence of extraneous factors such as stimulus presentation interval, or the stimulus media employed.

Crouse and Duncan (1963) and Bourne, Goldstein, and Link (1964) reported time to be a factor when considering method of presentation. For the simultaneous method to be superior to the successive, a longer presentation interval was necessary. In the present study presentation time was equated. Nadelman (1957) found that the efficiency of attaining concepts with the use of simultaneous and successive presentation was influenced by the stimulus media used. Drawings required fewer prompts per concept when presented successively as opposed to simultaneously. With

models the simultaneous method resulted in superior performance. In the present study stimuli were presented by means of slides which resembled drawings more closely than three-dimensional models.

Several other considerations become apparent in examining the method results. The Ss were required to form a relatively small number of concepts. However, their task was a difficult one due to the utilization of a large proportion of four-sided figures as negative instances. Gagné (1965) distinguishes eight types of learning, each beginning with a different state of the organism and ending with a different capability for performance. In order for concept learning to occur a S must be able to make multiple discriminations. The superiority of the successive presentation method might be attributed to the difficulty experienced by young Ss in discriminating the difference between trapezoids and four-sided negative instances in the simultaneous condition. The retarded discrimination would, in turn, hinder the development of concept learning.

The paucity of experiments concerned with the influence of the method of presentation employed during acquisition upon the transfer of a concept inhibits the drawing of generalizations. In the present study the method of stimulus presentation, although significant in acquisition, had no appreciable effect on the transfer task. The lack of a significant finding suggests that the method of presentation employed during acquisition will have little influence on a subsequent transfer task. As far as retention is concerned, the state of knowledge with regard to the variable of method of presentation is similar to the findings presented in the transfer literature. Little evidence is given as to which method of presentation will maximize the retention of a concept. The findings of the present study indicate that the method of presentation employed during concept acquisition will not influence concept retention.

In discussing acquisition, the present experimental finding that ratios of 100, 75, and 50 per cent positive instances were significantly (.01) superior to a ratio of 25 per cent positive instances is consistent with the results reported by a number of experimenters. Whitman and Garner (1963), Dominowski (1965), and Kurtz and Hovland (1956) reported the use of 100 per cent positive instances to be most advantageous in facilitating performance. Related to the experimental trend disclosing the superiority of 100 per cent positive instances are the results presented by Mayzner (1962) and Freibergs and Tulving (1961). Learning was facilitated when the number of positive instances was increased and the number of negative instances was decreased.

The results of the present study are in agreement with these experimental trends. The P25 group's performance was significantly (.01) inferior to the three higher positive ratio groups. Although no significant differences were found between the P50, P75, and P100 groups, graphic representation of acquisition curves revealed that the P100 group was consistently superior to the P50 and P75 groups; the P75 group made a higher percentage of correct responses than the P50 group. Thus, the findings of the present concept formation study are in accordance with the results of many concept identification experiments. The use of all positive instances leads to the most efficient concept formation.

The P25 group performed less well than the control group and was below the chance level of responding. Several factors, either singularly or in combination, could account for the significantly inferior performance of the P25 group. The ratio employed may have retarded discrimination due to the high preponderance of negative instances and the low frequency of trapezoids. Difficulties in discrimination may have occurred. Subjects had to differentiate between four-sided figures with one pair of parallel sides and four-sided figures with two pair of parallel sides. The Ss' set to respond may have been involved. Since a large proportion of the labeled instances were negative the Ss might have expected a large proportion of the unlabeled instances to be negative. An unlabeled test instance could also have been considered negative due to previous experience with a large variety of negative instances. In other words, unfamiliar test instances were subsumed within the class of negative instances due to the perceived broadness of the class.

In studying concept identification Fryatt and Tulving (1963) presented Ss with all positive or mixed (one positive and two negative) instances. The transfer task also involved positive or mixed instances. Transfer from mixed to mixed instances was superior to transfer from positive to mixed instances. The results of the present study are not in agreement with the Fryatt and Tulving findings. Practice with 100 per cent positive instances was superior to practice with a 25 or 75 per cent ratio.

It should be noted that the mixed ratio employed by Fryatt and Tulving does not coincide with any of the mixed ratios presented in the present study. Masilela (1964) simulated two of the ratio conditions utilized in the present experiment. Subjects were presented with 100 or 50 per cent ratios of positive to negative instances during acquisition. Although performance of the Ss receiving the 100 per cent ratio was superior on the acquisition task, Ss receiving the 50 per cent ratio were superior on a transfer task employing a 50 per cent ratio. The P50 group in the present study did not significantly differ from the P100 group. However, the relative ranking of the P50 group on the dependent variable changed. During acquisition the P75 group made a greater percentage of correct responses than the P50 group; on the transfer test the P50 group gave a greater percentage of correct responses.

Ellis (1965) considers degree of original learning to be a crucial factor influencing subsequent performance on a transfer task. It is difficult to compare the degree of original learning present in the Fryatt and Tulving study, the Masilela experiment, and the present study due to the diverse tasks and measurement criteria employed. Inconsistent experimental findings could be attributed to task differences, diverse S populations, or different degrees of original learning.

The marked improvement of the P25 group is also of interest. The performance of this treatment group was below chance level of responding on the acquisition task, indicating a slow rate of original learning. If Ss receiving the P25 condition were merely functioning at the discrimination level of learning it would be expected that performance would decline to a greater extent on the transfer task due to the increased similarity of the positive and negative instances utilized.

The mediational model employed by Masilela (1964) can aid in clarifying the P25 group's results. Positive instances and mixed positive and negative instances lead to differences in the patterns of relationships between initiating stimuli and terminating responses, and thus variations in the strengths of associations between stimuli and mediating responses; the effects may be facilitative, inhibitory, or neutral with respect to the formation of particular concepts. In a situation where mixed positive and negative instances are employed, the S responds to negative instances with different implicit responses. The responses evoked by positive instances in this situation are influenced by responses evoked by the negative instances. The presence of negative instances strengthens the association between positive instances. The mixed positive and negative instances should lead to a high degree of learning in spite of the slower rate of learning. In turn, transfer will be facilitated due to the strengthening of associations between positive instances.

In summarizing the proposed reasons for the lack of agreement between the findings of the present experiment and the results of previous studies, it should again be mentioned that both Fryatt and Tulving and Masilela presented college age Ss with a concept identification task. Therefore, differences could be due to task diversity or the Ss' age disparity. Also meriting consideration are the dependent variables employed and the ratio conditions utilized.

Lack of experimental evidence prevents the drawing of conclusions as to which ratio of positive to negative instances employed during acquisition will maximize retention. In the present study the main effect of ratio was not significant on the retention test.

Unlike the Hovland and Weiss (1953) study the present experiment did not find an interaction between method of presentation and ratio of positive to negative instances. However, Hovland and Weiss examined concept identification, sampled a different S population, and made statistical comparisons across three experiments.

The repeated measure of blocks of trials was utilized in the acquisition phase so that measures of performance could be taken at intervals throughout acquisition. Although the blocks effect was not one of the variables under investigation, this main effect merits attention due to the significance (.05) disclosed and the failure of all treatment groups to conform to the usual acquisition curve. Subsequent analysis of the block effect by means of the Newman-Keuls procedure disclosed a significant difference between the first and second block of trials. All eight treatment groups gave a lower percentage of correct responses in the second block. Since the four ratio groups were presented with different proportions of positive instances, only two instances, both positive, were common to all treatment groups. The possibility exists that these common positive instances were difficult for the Ss to discriminate as trapezoids due to their angles, lengths of lines, and orientation. More likely, the decline in performance was related to two of the test instances which the Ss had difficulty in differentiating as trapezoids, apparently due

to the length of lines and orientation of these test figures.

The present study examined the stimulus variables of the method of presentation and ratio of positive to negative instances under three tasks in order to gain further information toward the goal of promoting efficient concept learning. Unlike previous experiments manipulating the two stimulus variables, a concept formation task, rather than a concept identification task, was employed. It could be argued that the task was not concept formation, that the Ss were merely required to make a perceptual discrimination. Since all test instances were positive the Ss were credited with a correct answer if they circled Yes on their sheets. However, all training instances were labeled figures. The label was also associated with the correct response by means of instructions. Subjects were requested to circle Yes if the figure was a trapezoid. The Ss' task in the present study falls under the conditions which Gagne (1965) delineates as necessary for concept learning. Gagné explains that the prerequisite of multiple discrimination learning must be achieved by the S in order that concept learning may occur.

Situational conditions must include specific stimulus objects that have a common characteristic. In the present study all Ss received a minimum of 25 per cent positive instances. All positive instances were quadrilaterals possessing one pair of parallel sides.

Gagné also reports that the S must be able to identify additional instances of the class using new stimuli. In the present study test instances varied from training instances across the three dimensions of length of lines, degree of angles, and orientation. All instances employed in the transfer task were novel. Gagné feels that to test for the presence of concepts is to demonstrate that generalization may occur, generalization to a variety of specific instances of the class that have not been used in learning.

In considering the task conditions employed in the present study, it becomes apparent that a direct comparison to concept identification literature was necessitated because of the paucity of concept formation experiments manipulating the independent variables of method and ratio. The present study was limited in that the goal was to determine the effects of the independent variables of method of presentation and ratio of positive to negative instances upon the acquisition, transfer, and retention of the geometric concept trapezoid.

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